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SIGNIFICANCE OF WHEAT HAIRS IN MICROSCOPICAL EXAMINATION OF FLOUR.

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PURPOSE OF METHOD.

Since the publication of United States Department of Agriculture Bulletin 839, "The Microscopical Examination of Flour," further study has suggested that the number of wheat hairs present in a weighed portion of the sample might be of value in classifying it.

Heretofore the grading of a flour by the original method has depended upon a count of the bran particles and hairs in a weighed portion of the sample. In practice, however, the identification of bran particles appears to be a more difficult task for the untrained eye than the recognition of wheat hairs or fragments of hairs. The bran particles occur in the flour in such a variety of forms that an analyst unaccustomed to the differentiation of histological sections under the microscope may encounter difficulties in obtaining consistent bran-particle counts. The wheat hairs and hair fragments, on the other hand, are readily identified and the quantity present in a sample has been found to be indicative of the flour grade.[1]

METHOD.

The method employed, which is similar to the one described in Department Bulletin 839, with some modifications, is as follows:

Carefully weigh out upon an accurate balance a 5-milligram portion of flour and transfer the weighed portion to the center of a microscope slide the surface of which has been ruled with lines running lengthwise and 1 millimeter apart. The flour having been transferred to the slide, mix about 4 drops of chloral hydrate solution (1:1) with the flour by means of a preparation needle. After making a uniform mixture of the flour and the chloral hydrate solution, apply a coverglass 22 millimeters square and gently warm the slide on the hot

[1] The term "grade" is here used in a general way, to classify the assembled types of flour.

plate until the preparation is properly cleared. The clearing is complete when the preparation becomes transparent. Then transfer the slide to the stage of the microscope and allow it to remain until no movement is evident in the mount when viewed under the microscope. Count the hairs and hair fragments. The magnification giving approximately 180 diameters here employed was obtained by the use of compensating ocular 12 × and 16-millimeter apochromatic objective. If apochromatic objectives are not available, an achromatic objective with an ordinary eyepiece giving the same magnification is satisfactory.

COUNTING THE HAIRS.

The counting of a slide consists in the methodical enumeration of all the hairs and hair fragments in the mount (Fig. 1). By means

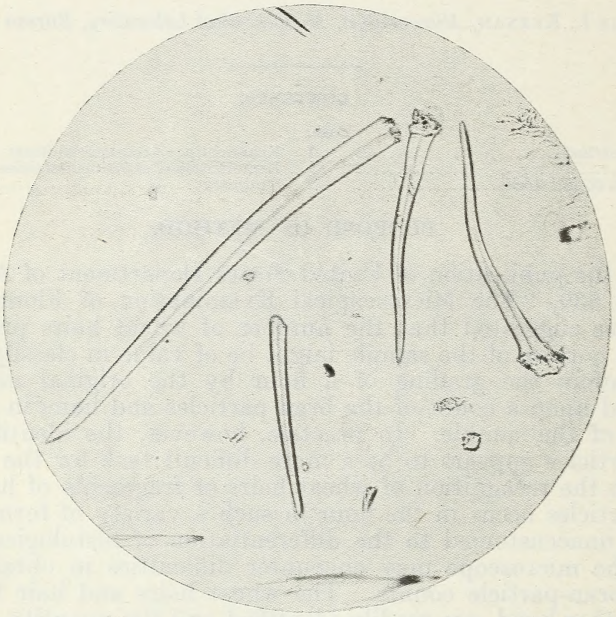

FIG. 1.—Wheat hairs (×180).

of the mechanical stage on the microscope, no difficulty is encountered in thoroughly and accurately covering the entire mount. Each hair and hair fragment is given a value of 1, the final number being taken as the value for the flour in question.

SOURCES OF VARIATION IN METHOD.

Department Bulletin 839 contains a full discussion of tests conducted to determine the sources of variation in such a method. It is evident that the variation in the counts made by two analysts is greater in the case of bran particles than in the case of hairs.

EXAMINATION OF MILL STOCKS.

Modern milling processes consist essentially in releasing the floury endosperm from the wheat grain, purifying it of bran substance, and eventually reducing it to what is known as flour. Any manipula-

tion in the various steps of milling leading to the removal of an insufficient quantity of the bran material will eventually reveal itself in the finished flour. The method already described has been devised to detect such irregularities.

The break rolls in a mill are designed to crush the wheat kernel so that the inclosed endosperm may be released and later reduced to the fineness of flour on the smoother rolls. The general practice in milling is to make as little break flour as possible. When made to any extent, break flour invariably contains a large quantity of offal, consisting of hairs, hair fragments, and bran particles. The middlings

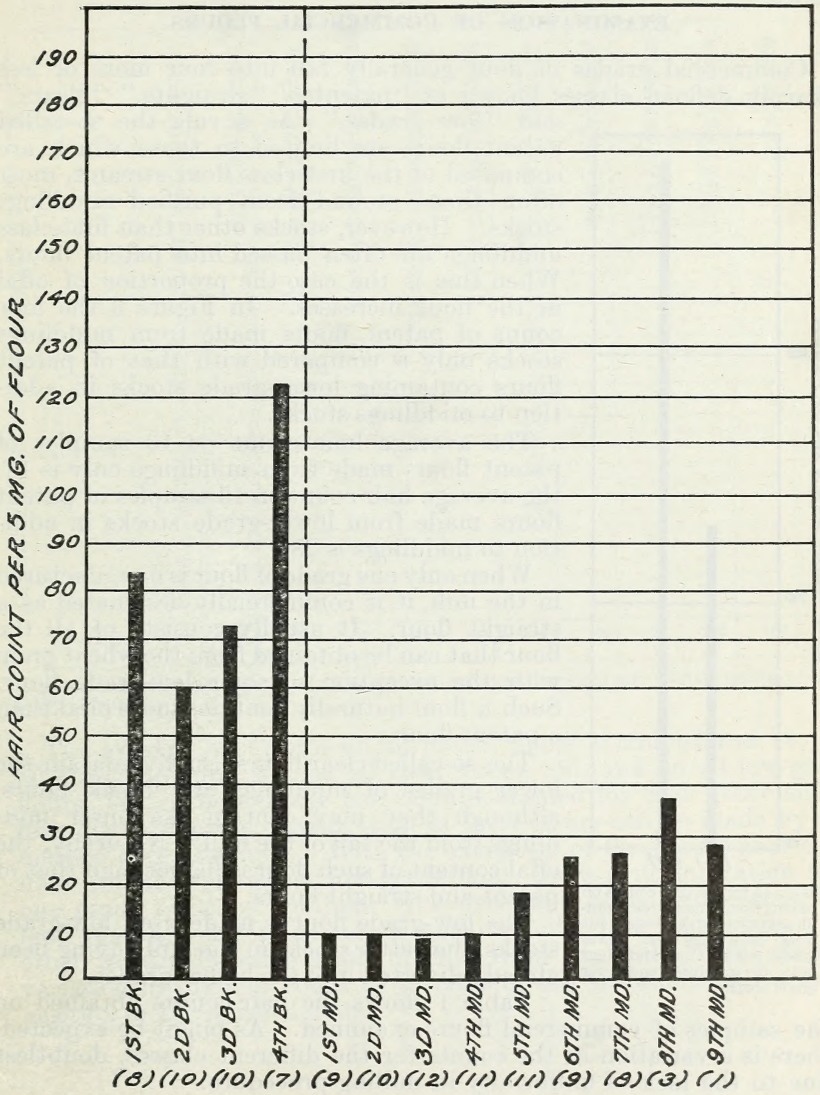

FIG. 2.—Average hair counts on 35 break flours and 74 middlings flours.

(granular particles of endosperm), on the contrary, are relatively free from hairs and bran particles after proper purification.

To illustrate these differences in break stocks and middlings stocks, a composite chart (Fig. 2) has been constructed. It is based on data obtained from 35 break flours and 74 middlings flours, the hair count being the average on all samples examined for each grade.

The break flours in each instance show a much higher hair count than any of the middlings stocks. The hair count of the middlings stock begins to increase with the fifth middlings, indicating that the first four middlings are much cleaner than the succeeding ones in the series.

EXAMINATION OF COMMERCIAL FLOURS.

Commercial grades of flour generally fall into four more or less sharply defined classes known as "patents," "straights," "clears," and "low grades." As a rule the so-called patent flours are limited to those which are composed of the first-class flour streams, most often those ground from purified middlings stocks. However, stocks other than first-class middlings are often passed into patent flours. When this is the case the proportion of offal in the flour increases. In Figure 3 the hair count of patent flours made from middlings stocks only is compared with that of patent flours containing lower-grade stocks in addition to middlings stocks.

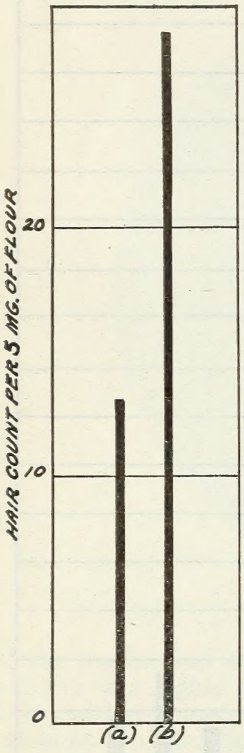

FIG. 3.—Average hair counts on patent flours made from middlings only and on those made from middlings and lower grade stocks. (*a*) Middlings only; (*b*) middlings and lower grade stocks.

The average hair count on 13 samples of patent flours made from middlings only is 13; the average hair count on 13 samples of patent flours made from lower-grade stocks in addition to middlings is 28.

When only one grade of flour is manufactured in the mill, it is commercially designated as a straight flour. It usually consists of all the flour that can be obtained from the wheat grain with the exception of some low-grade flour. Such a flour naturally contains more offal than a patent flour.

The so-called clear flours usually contain the lower grades of middlings and break flours, although they may contain the purer middlings from the tail of the mill. Naturally, the offal content of such flour is higher than that of patent and straight flours.

The low-grade flour is made from low-grade stocks, the better stocks in the mill having been already diverted into the higher grades.

Table 1 shows the hair counts obtained on the samples of commercial flours examined. As might be expected, there is a variation in the counts for the different classes, doubtless due to the lack of uniformity in milling procedure.

Figure 4 illustrates the differences between the four so-called commercial grades of flour, based on the average hair count obtained for

all samples examined under each grade. According to the manufacturers, these flours had been milled from hard, blended, and soft wheats, respectively, and the results obtained have been classified under these three general classes of wheat.

TABLE 1.—*Hair counts obtained on commercial samples of flour.* [1]

Sample No.	Patent flours.			Straight flours.			Clear flours.			Low-grade flours.		
	Hard wheat.	Blended wheat.	Soft wheat.	Hard wheat.	Blended wheat.	Soft wheat.	Hard wheat.	Blended wheat.	Soft wheat.	Hard wheat.	Blended wheat.	Soft wheat.
1	34	17	10	34	26	40	45	61	72	91	132	27
2	9	21	25	55	22	31	147	65	68	129	131	257
3	15	40	11	45	28	38	114	73	32	131	94	145
4	23	27	32	33	18	58	133	40	39	112	183	261
5	12	19	1	25	36	26	43	96	40	155	141	219
6	30	13	34	39	40	60	178	45	44	88	76	139
7	10	37	17	31	31	70	49	49	143	301	61	124
8	16	25	12	51	38	54	57	47	167	335	59	80
9	19	15	22	61	47	27	71	142	30	264	.....	.....
10	9	18	29	87	30	71	93	98	66	163	.....	.....
11	28	13	19	65	28	81	71	44	99	238	.....	.....
12	31	13	26	19	29	40	102	67	164	.....	.....	.....
13	28	.....	30	26	26	22	204	.....	155	.....	.....	.....
14	24	.....	.....	47	37	34	140	.....	.....	.....	.....	.....
15	13	.....	.....	61	45	39	196	.....	.....	.....	.....	.....
16	39	.....	.....	17	47	34	124	.....	.....	.....	.....	.....
17	36	.....	.....	22	58	38	67	.....	.....	.....	.....	.....
18	2	.....	.....	.....	37	.....	68	.....	.....	.....	.....	.....
19	33	.....	.....	.....	.....	.....	39	.....	.....	.....	.....	.....
20	2	.....	.....	.....	.....	.....	119	.....	.....	.....	.....	.....
21	26	.....	.....	.....	.....	.....	136	.....	.....	.....	.....	.....
22	14	.....	.....	.....	.....	.....	62	.....	.....	.....	.....	.....
23	4	.....	.....	.....	.....	.....	184	.....	.....	.....	.....	.....
24	10	.....	.....	.....	.....	.....	102	.....	.....	.....	.....	.....
25	11	.....	.....	.....	.....	.....	223	.....	.....	.....	.....	.....
26	12	.....	.....	.....	.....	.....	126	.....	.....	.....	.....	.....
27	21	.....	.....	.....	.....	.....	77	.....	.....	.....	.....	.....
28	15	.....	.....	.....	.....	.....	98	.....	.....	.....	.....	.....
29	20	.....	.....	.....	.....	.....	50	.....	.....	.....	.....	.....
30	20	.....	.....	.....	.....	.....	166	.....	.....	.....	.....	.....
31	5	.....	.....	.....	.....	.....	132	.....	.....	.....	.....	.....
32	9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
33	45	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
34	13	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
35	13	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
36	8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Average	18	21	20	42	34	44	110	68	86	182	109	156

[1] As the flours examined were milled under different conditions the counts vary with the milling practices at the various mills.

The average hair count on all patent flours examined was 19; on all straight flours, 40; on all clear flours, 88; and on all low-grade flours, 149. The average hair count obtained for each grade shows how distinctive the classification of these flours can be made by the method here described. With the exception of the hard-wheat clear flour and the soft-wheat low-grade flour, there is no indication that one grade overlaps another. The exception noted emphasizes the fact that grading practices in various mills lack uniformity. In other words, the same grade of flour from two mills might show a variation in the hair count as a result of the variations in the composition of the finished flour.

EXAMINATION OF EXPERIMENTAL SERIES OF FLOUR.

A study was also made of samples of flour whose composition, in so far as the mill streams entering into them is concerned, was definitely known.

Table 2 shows the hair counts obtained on these samples. These counts are more uniform and consistent than those for the commercial flours examined (Table 1). The results have been plotted in Figure 5.

An examination of the results obtained on the experimental series of flours, as compared with those obtained on the commercial flours, justifies the statement previously made that but little uniformity exists in grading finished flours in different mills. In other words, there is less overlapping between grades in the experimental flours than there is in commercial flours.

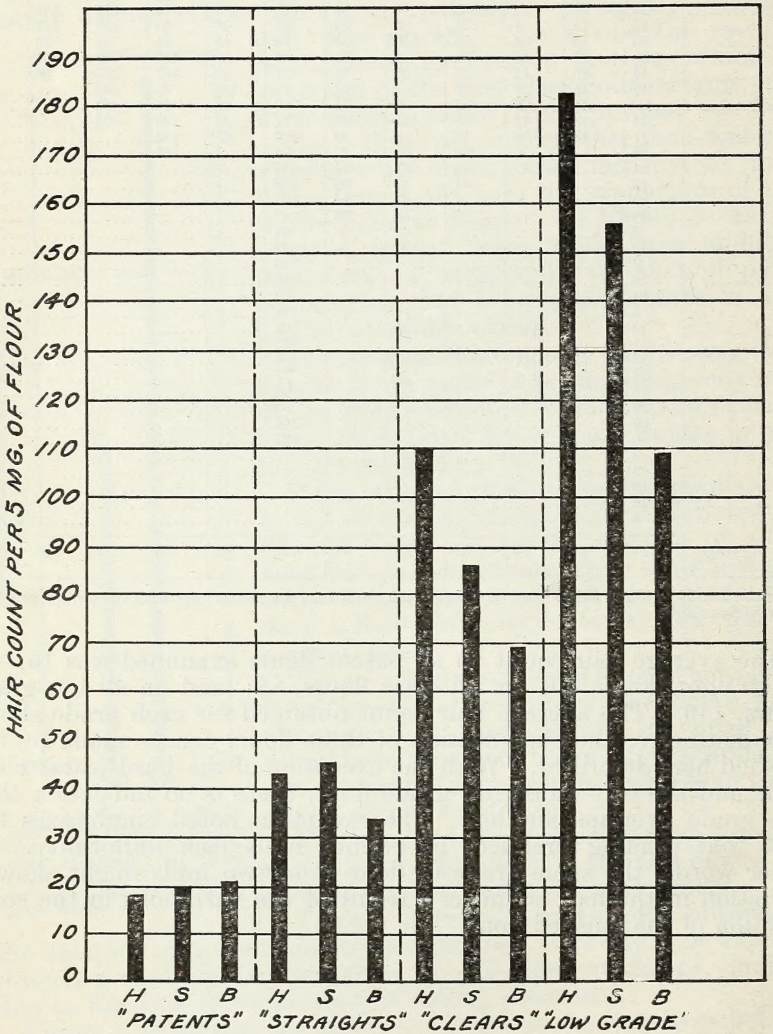

FIG. 4.—Average hair count on 61 patent, 56 clear, 52 straight, and 16 low-grade flours.

TABLE 2.—*Hair counts obtained on experimental samples of flour.* [1]

Sample No.	Types of flour.				
	70 per cent.	97.5 per cent.	90 per cent.	27.5 per cent.	2.5 per cent.
1	13	28	26	45	129
2	13	29	22	49	131
3	18	26	28	47	112
4	12	39	31	65	.....
5	9	29	28	51	.....
6	.....	30	34	40	.....
Average	13	30	28	49	124

[1] As these flours were made under the supervision of the Bureau of Chemistry, their constituent streams were known. A description of the streams composing them is given in Department of Agriculture Bulletin 839.

SUMMARY.

Experimental data secured by the Bureau of Chemistry have shown in a general way the existence of a significant relationship between the wheat-hair count and the flour classified according to milling practices. Reliable information on the quality of the mill streams composing any finished flour was available only in the case of the experimental samples of flour. Consequently, any suggestion as to the tolerance to be applied in a method of this kind would be justified only when definite information concerning the milling process, such as the streams employed in composing a flour and the cleaning of the wheat, is at hand.

The data obtained on the experimental samples of flour, however, indicate the possibility of making an interesting classification based on the hair count alone. It is possible, of course, that the number of hairs or hair fragments from the brush of the wheat grain might differ materially, according to the variety of wheat used and the milling operations employed. Nevertheless, an examination of a large number of samples representing a great variety of milling practices indicates that flours made from purified middlings material show a low hair count, while flours containing lower-grade mill stocks show a higher hair count.

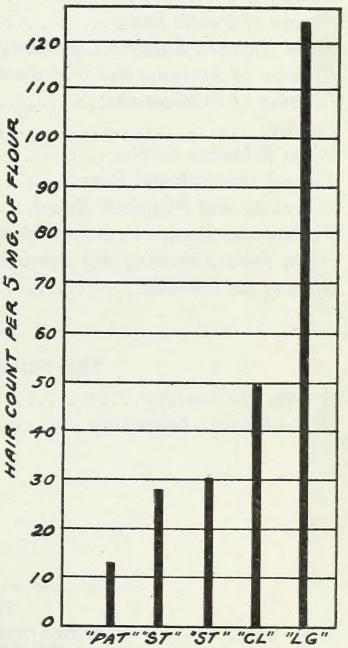

FIG. 5.—Average hair count on a 70 per cent patent, 90 and 97.5 per cent straight, 27.5 per cent clear, and 2.5 per cent low-grade flour.

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